



Assembly Instructions: Optocouplers and Solid-State Relays

GENERAL

Vishay offers a wide product selection of optocouplers and solid state relays in a variety of packages. This document provides instructions on mounting for the different types of packages, specifically on the different methods of soldering. For DIP packages, they can be mounted in DIP sockets or directly on a pre-designed PCB with holes.

The preferred solder process for SMD packages is reflow soldering. Certain SMD families are also qualified for wave soldering; please see table 1. Most couplers have a moisture sensitivity level (MSL) = 1. Some SMD couplers have a moisture level sensitivity (MSL) = 3 or 4. Please follow the datasheet for soldering guidelines and detailed technical specifications.

If the device is to be mounted near heat-generating components, consideration must be given to the resultant increase in ambient temperature.

SOLDERING INSTRUCTIONS

Protection against overheating is essential when a device is being soldered. Therefore, the connection wires or PCB traces should be left as long as possible. The maximum permissible soldering temperature is governed by the maximum permissible heat that may be applied to the package.

The maximum soldering iron (or solder bath) temperatures are given in the individual datasheets. During soldering, no forces must be transmitted from the pins to the case (e.g., by spreading the pins).

SOLDERING METHODS

There are several methods for soldering devices onto the substrate. The following is a partial list.

(a) Soldering in the vapor phase

Soldering in saturated vapor is also known as condensation soldering. This soldering process is used as a batch system (dual vapor system) or as a continuous single vapor system. Both systems may also include a pre-heating of the assemblies to prevent high-temperature shock and other undesired effects.

(b) Reflow soldering of lead (Pb)-free SMD devices

By using infrared (IR) reflow soldering, the heating is contact-free and the energy for heating the assembly is derived from direct infrared radiation and from convection.

The heating rate in an IR furnace depends on the absorption coefficients of the material surfaces and on the ratio of the component's mass to an as-irradiated surface.

The temperature of parts in an IR furnace, with a mixture of radiation and convection, cannot be determined in advance. Temperature measurement may be performed by measuring the temperature of a certain component while it is being transported through the reflow oven.

Note

⁽¹⁾ Wave soldering three cycles parts are exceptions which is mentioned on the datasheet

Influencing parameters on the internal temperature of the component are as follows:

- Time and power
- Mass of the component
- Size of the component
- Size of the printed circuit board
- Absorption coefficient of the surfaces
- Packing density
- Wavelength spectrum of the radiation source
- Ratio of radiated and convected energy

Temperature/time profiles of the entire process and the influencing parameters are given. The IR reflow profile is shown in Fig. 1. Two cycles of reflow are allowed.

(c) Wave soldering

In wave soldering one or more continuously replenished waves of molten solder are generated, while the substrates to be soldered are moved in one direction across the crest of the wave. Maximum soldering temperature should not exceed 260 °C.

Temperature/time profiles of the entire process are given in Fig. 2.

For SMD devices which are qualified for wave soldering, the temperature profile under Fig. 2 is also valid. For wave soldering two cycles are allowed ⁽¹⁾.

(d) Iron soldering

This process cannot be carried out in a controlled situation. It should therefore not be used in applications where reliability is important. There is no SMD classification for this process.

(e) Laser soldering

This is an excess heating soldering method. The energy absorbed may heat the device to a much higher temperature than desired. There is no SMD classification for this process at the moment.

(f) Resistance soldering

This is a soldering method which uses temperature-controlled tools (thermodes) for making solder joints. There is no SMD classification for this process at the moment.

**TABLE 1 - SOLDERING METHODS AND TEMPERATURE PROFILES FOR OPTOCOUPLER LINES**

			REFLOW	WAVE SOLDERING 260 °C	
			SMD	SMD	THROUGH HOLE
				PACKAGE THROUGH WAVE	PACKAGE NOT THROUGH WAVE
PACKAGE	PART NUMBER EXAMPLES	ASSEMBLY METHOD	TEMP. PROFILE Fig. 1	TEMP. PROFILE Fig. 2	TEMP. PROFILE Fig. 2
DIP-6	H11; IL250; IL410	Through hole			X
DIP-8	IL300; 6N135	Through hole			X
DIP-4/8/16	SFH617A-2; SFH615	Through hole			X
DIP-6	CNY17	Through hole			X
DIP-4/8/16	TCET1104; TCET1104G	Through hole			X
DIP-4/8/16	VO615A	Through hole			X
DIP-6	CQY80NG; CNY75B; TCDT	Through hole			X
DIP-4/8/16	VO615A series	SMD bend.opt.	X	No	
DIP-4	SFH6106	SMD bend.opt.	X	Yes	
DIP-8 high speed	SFH6700; 6N135; SFH6325	SMD bend.opt.	X	No	
DIP-6	Types with option 7, 8 or 9	SMD bend.opt.	X	No	
DIP-8	IL300	SMD bend.opt.	X	No	
SSOP-4	TCMT; TCLT series	SMD	X	Yes	
SSOP-16	SFH6916; TCMT4xxx	SMD	X	No	
SOP-4 (Miniflat)	SFH690	SMD	X	No	
SO8	ILD205T; ILD207AT	SMD	X	No	
SO8	VO026..; VO46..; VO06..	SMD	X	Yes	
SSR's					
DIP-4	LH1546AD	Through hole			X
DIP-6	LH1500AT	Through hole			X
DIP-8	LH1526AB	Through hole			X
DIP-6	LHxxxBT	Through hole			X
DIP-8	LHxxxBB	Through hole			X
DIP-4	LH1546ADF	SMD bend.opt.	X	No	
DIP-6	LH1500AAB	SMD bend.opt.	X	No	
DIP-8	LH1526AAC	SMD bend.opt.	X	No	
Miniflat	LH1546AEF; VO14..	SMD	X	No	
DIP-6	LHxxxBAB	SMD bend.opt.	X	No	
DIP-8	LHxxxBAC	SMD bend.opt.	X	No	
DIP-8	VORA1150..	SMD	X	Yes	

TEMPERATURE-TIME PROFILES

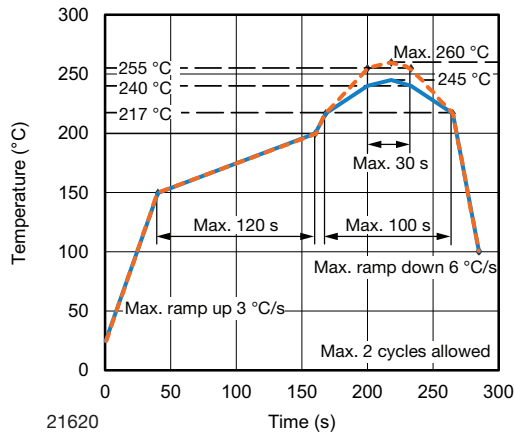


Fig. 1 - Temperature Profile for Lead (Pb)-free Opto Devices

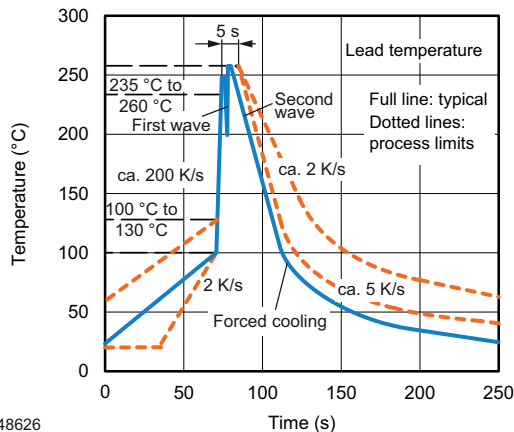


Fig. 2 - Wave Soldering Double Wave Opto Devices

HEAT REMOVAL

The heat generated in the semiconductor junction(s) must be moved to the ambient. In the case of low-power devices, the natural heat conductive path between case and surrounding air is usually adequate for this purpose.

In the case of medium-power devices, however, heat conduction may have to be improved by the use of star- or flag-shaped heat dissipators which increase the heat radiating surface.

The heat generated in the junction is conveyed to the case or header by conduction rather than convection; a measure of the effectiveness of heat conduction is the inner thermal resistance or junction-to-case thermal resistance, R_{thJC} , whose value is given by the construction of the device.

Any heat transfer from the case to the surrounding air involves radiation convection and conduction, the effectiveness of transfer being expressed in terms of an R_{thCA} value, i.e., the case-to-ambient thermal resistance.

The total thermal resistance, junction-to-ambient is therefore: $R_{thJA} = R_{thJC} + R_{thCA}$

The total maximum power dissipation, $P_{totmax.}$, of a semiconductor device can be expressed as follows:

$$P_{totmax.} = \frac{T_{jmax.} - T_{amb}}{R_{thJA}} = \frac{T_{jmax.} - T_{amb}}{R_{thJC} + R_{thCA}}$$

where:

$T_{jmax.}$ the maximum allowable junction temperature

T_{amb} the highest ambient temperature likely to be reached under the most unfavorable conditions

R_{thJC} the thermal resistance, junction-to-case

R_{thJA} the thermal resistance, junction-to-ambient

R_{thCA} the thermal resistance, case-to-ambient, depends on cooling conditions. If a heat dissipator or sink is used, then R_{thCA} depends on the thermal contact between case and heat sink, heat propagation conditions in the sink and the rate at which heat is transferred to the surrounding air.

Therefore, the maximum allowable total power dissipation for a given semiconductor device can be influenced only by changing T_{amb} and R_{thCA} . The value of R_{thCA} could be obtained either from the data of heat sink suppliers or through direct measurements.

In the case of cooling plates as heat sinks, the approach outlined in Fig. 3 and Fig. 4 can be used as guidelines. The curves shown in both Fig. 3 and Fig. 4 give the thermal resistance R_{thCA} of square plates of aluminum with edge length, a , and with different thicknesses. The case of the device should be mounted directly onto the cooling plate.

The edge length, a , derived from Fig. 3 and Fig. 4 in order to obtain a given R_{thCA} value, must be multiplied with α and β :

$$\alpha' = \alpha \times \beta$$

where

$\alpha = 1.00$ for vertical arrangement

$\alpha = 1.15$ for horizontal arrangement

$\beta = 1.00$ for bright surface

$\beta = 0.85$ for dull black surface

Example

For an IR emitter with $T_{jmax.} = 100^\circ\text{C}$ and $R_{thJC} = 100\text{ K/W}$, calculate the edge length for a 2 mm thick aluminum square sheet having a dull black surface ($\beta = 0.85$) and vertical arrangement ($\alpha = 1$), $T_{amb} = 70^\circ\text{C}$ and $P_{tot max.} = 200\text{ mW}$.

$$P_{totmax.} = \frac{T_{jmax.} - T_{amb}}{R_{thJC} + R_{thCA}}$$

$$R_{thCA} = \frac{T_{jmax.} - T_{amb}}{P_{totmax.}} - R_{thJC}$$

$$R_{thCA} = \frac{100^\circ\text{C} - 70^\circ\text{C}}{0.2\text{ W}} - 100\text{ K/W}$$

$$R_{thCA} = \frac{30}{0.2} = 150 \text{ K/W}$$

$$R_{thCA} = 50 \text{ K/W}$$

$$\Delta T = T_{case} - T_{amb}$$

can be calculated from the relationship:

$$P_{totmax.} = \frac{T_{jmax.} - T_{amb}}{R_{thJC} + R_{thCA}} = \frac{T_{case} - T_{amb}}{R_{thCA}}$$

$$\Delta T = T_{case} - T_{amb} = \frac{R_{thCA} \times (T_{jmax.} - T_{amb})}{R_{thJC} + R_{thCA}}$$

$$\Delta T = \frac{50 \text{ K/W} \times (100^\circ\text{C} - 70^\circ\text{C})}{150 \text{ K/W}}$$

$$\Delta T = \frac{50 \text{ K/W} \times 30^\circ\text{C}}{150 \text{ K/W}}$$

$$\Delta T = 10^\circ\text{C} = 10 \text{ K}$$

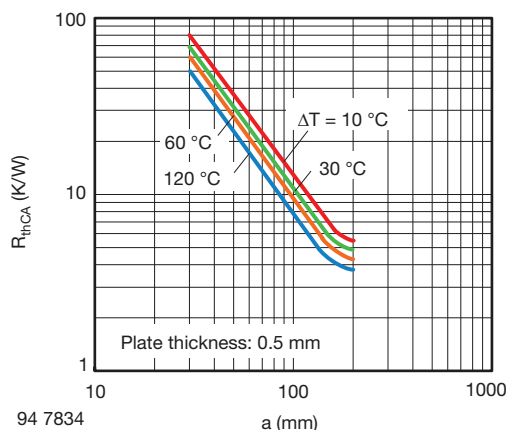


Fig. 3

With $R_{thCA} = 50 \text{ k/W}$ and $\Delta T = 10^\circ\text{C}$, a plate of 2 mm thickness has an edge length $a = 28 \mu$.

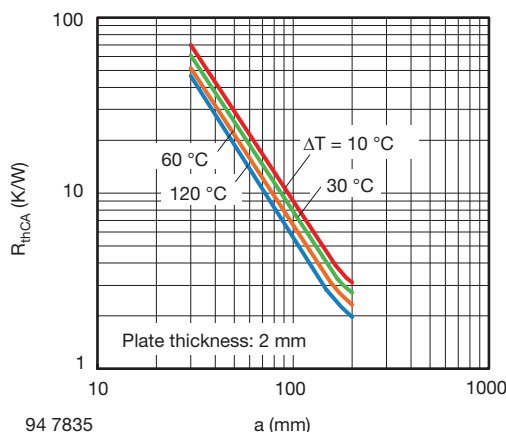


Fig. 4

However, equipment life and reliability have to be taken into consideration and therefore a larger sink would normally be used to avoid operating the devices continuously at their maximum permissible junction temperature.

Note

- The information in this document provides generic information but for specific information on a product the appropriate product datasheet should be used